画像情報特論 (1)
Advanced Image Information (1)

⇨ Advanced Visual Communication ?

はじめに
Class Overview

情報理工学専攻　甲藤二郎
Dept. of Computer Science and Engineering, Jiro Katto
E-Mail: katto@waseda.jp

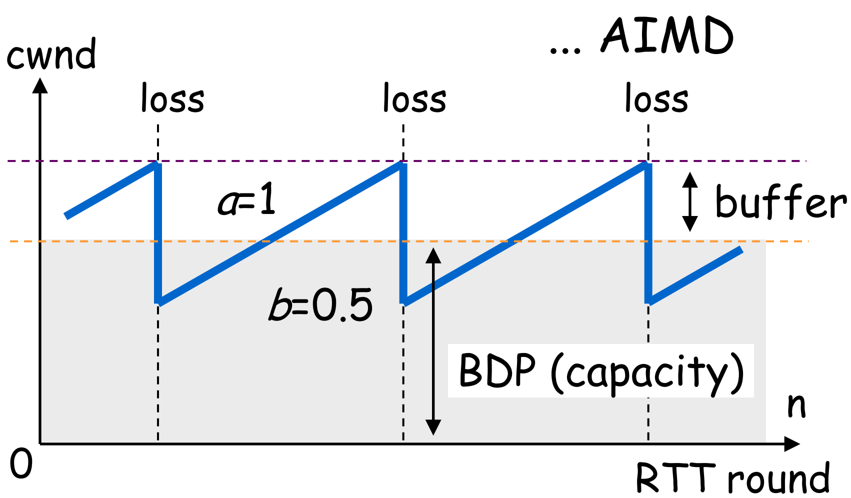
This Year's Schedule

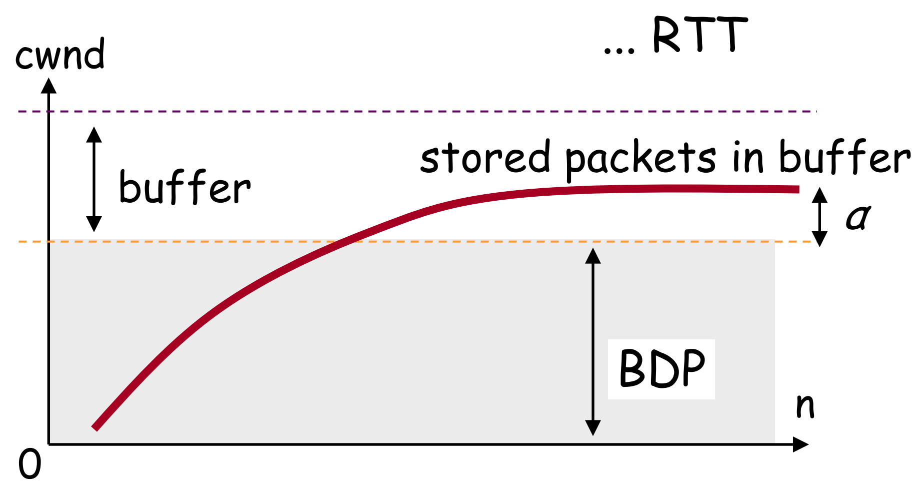
(tentative)

4/12	Class overview
4/19	Video Streaming (1) TCP/IP
4/26	Video Streaming (2) TFRC, HTTP
5/10	Self-study (CourseN@vi)
5/17	Self-study (CourseN@vi)
5/24	Video Streaming (3) Wireless & Sensor
5/31	Video Streaming (4) CDN, P2P, ICN/CCN
6/07	Video Compression (1) H.264/AVC
6/14	Video Compression (2) H.265/HEVC
6/21	Image Processing (1) Super-Resolution
6/28	Image Processing (2) 3D Image Processing
7/05	"3D Image Conference" will be held on 7/4-5 in this campus
7/12	Image Processing (3) Feature Extraction
7/19	Image Processing (4) Sparse Coding
TBD	Final report

Video streaming (1) TCP/IP

- Loss-driven
- Delay-driven





TCP-Reno, High-Speed TCP, TCP-Westwood, CUBIC-TCP, ...

TCP-Vegas, FAST-TCP

BDP/Buffer relationship

small buffer → ×efficiency
large buffer → ×delay

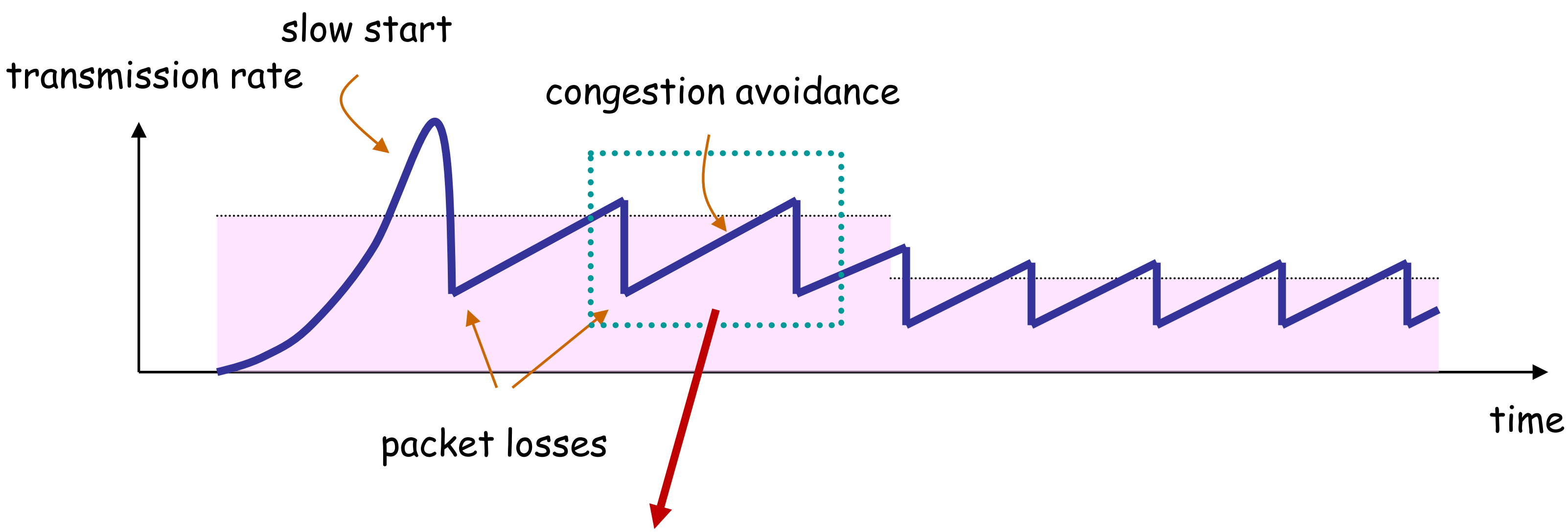
Unfairness by loss-driven TCP

×friendliness

BDP: Bandwidth-Delay Product

Video streaming (2) TFRC

- TFRC



Modeling of steady-state TCP behaviors

$$R = \frac{1}{RTT}\sqrt{\frac{3}{2p}}$$

p: packet loss rate

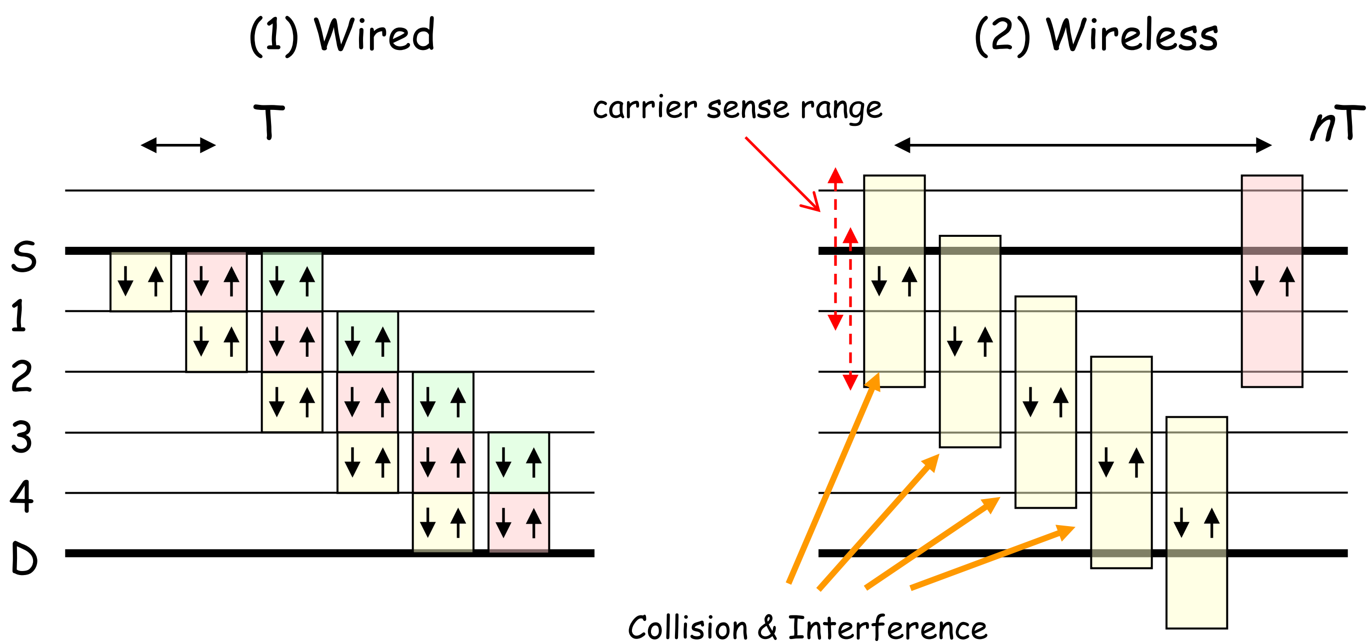
BDP/Buffer relationship

small buffer → × efficiency
large buffer → × delay

TFRC: TCP Friendly Rate Control

Video streaming (3) Wireless

- Single-Channel Multi-hop Network

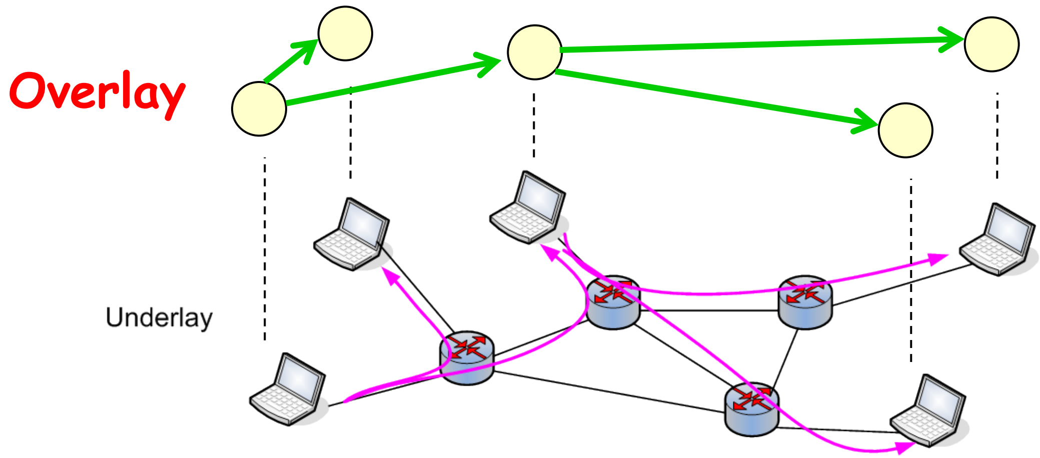


Channel Efficiency = 1

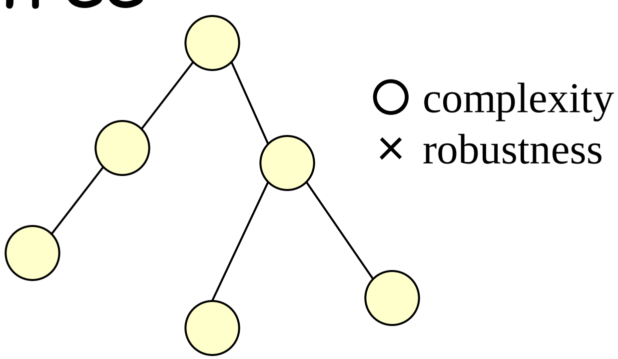
Channel Efficiency = $1/n$
(n : # of multi-hops)

Video streaming (4) CDN, P2P & Cloud

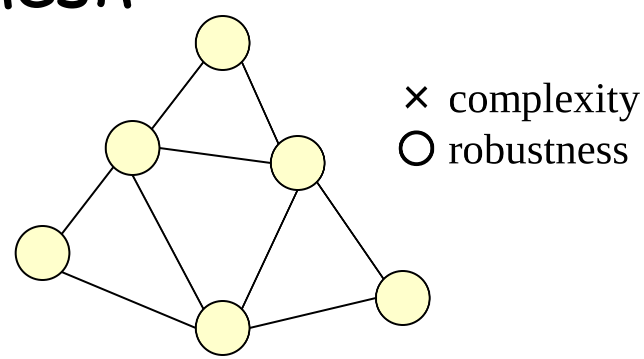
- Overlay networks



- tree



- mesh

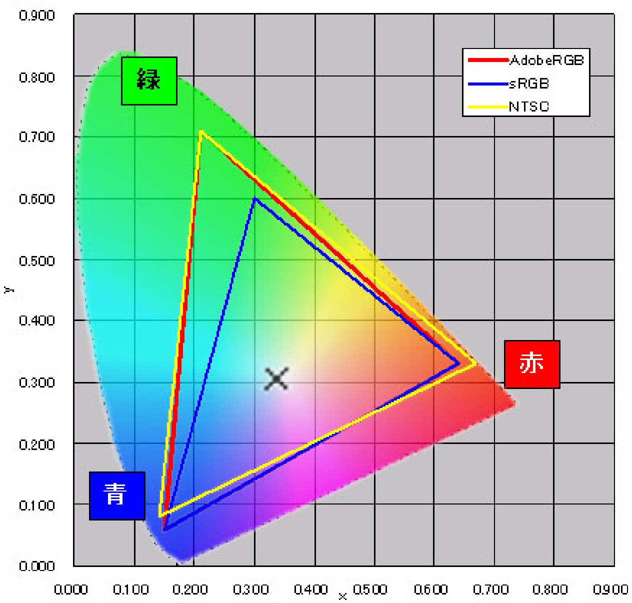


Video Compression (2) H.265

- H.265/HEVC
  - HEVC: High Efficiency Video Coding
  - NGVC: Next Generation Video Coding

- Other topics
  - Higher resolution
    - spatial: U-HDTV
    - temporal: 10,000 frames
  - Gamut expansion
  - High dynamic range
  - 3D / freeviewpoint

color diagram



http://plusd.itmedia.co.jp/pcuser/articles/0805/23/news001.html

Super-resolution

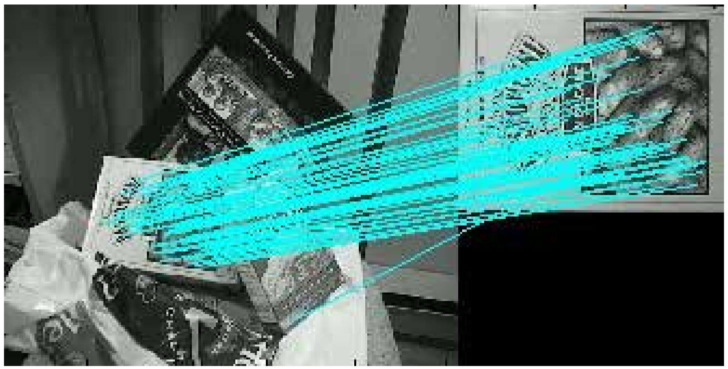
- Super-resolution
  - Missing frequency estimation (freq. domain)
  - Multiple image approach (registration)
  - Single image approach (example-based, data-base)

a: LR Frame 45 b: Data Fused Frame 45 c: Deblurred Frame 45

S.Farsiu et al.: "Advances and Challenges in Super-Resolution", IJIST, Aug.2004.

Feature Extraction

- Scale Invariant Feature Transform



SIFT descriptors

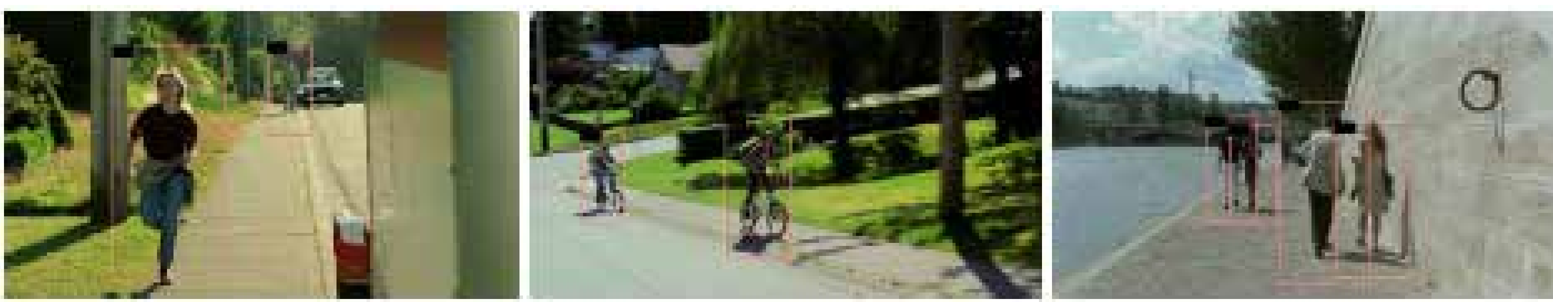
Point correspondence

oriented gradients

in local regions

- Histogram of Oriented Gradient

Human body detection



http://www.cs.ubc.ca/~lowe/keypoints/, http://www.navneetdalal.com/

Sparse Coding (1)

- Sparse Decomposition

$$\mathbf{f} = A\mathbf{s}$$

M=N: complete (orthogonal, unique)

M>N: overcomplete (<u>infinite solutions</u>)

f: N-d vector (input)

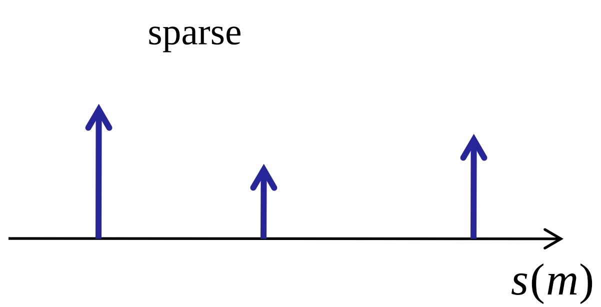
A: MxN matrix (transform matrix)

s: M-d vector (transform coefficient)

$$\hat{\mathbf{s}} = \arg\min_{s} \frac{1}{2}\left\|\mathbf{f} - A\mathbf{s}\right\|_2^2 + \lambda\left\|\mathbf{s}\right\|_1$$

L2-norm (Euclid)

L1-norm



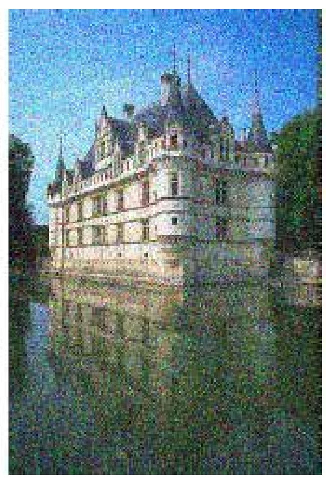
Sparse Coding (2)

- Sparse Coding

$$\left(\hat{A},\hat{s}\right)=\arg\min_{A,\mathbf{s}}\frac{1}{2}\sum_i\left\|\mathbf{f}_i-A\mathbf{s}_i\right\|_2^2+\sum_i\left\|\mathbf{s}_i\right\|_1$$

Basis vector learning from sample images

Original



Noisy (12.77dB)

Denoise (29.87dB)

http://www.cs.technion.ac.il/~elad/talks/

Preparation

- Tools
  - ns-2 / ns-3
  - OpenCV
  - MATLAB (Image Processing Toolbox)